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A PROTOTYPE SYSTEM APPROACH FOR THE DEFINITION OF  
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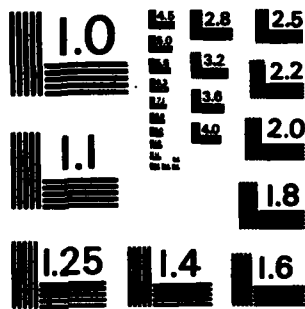


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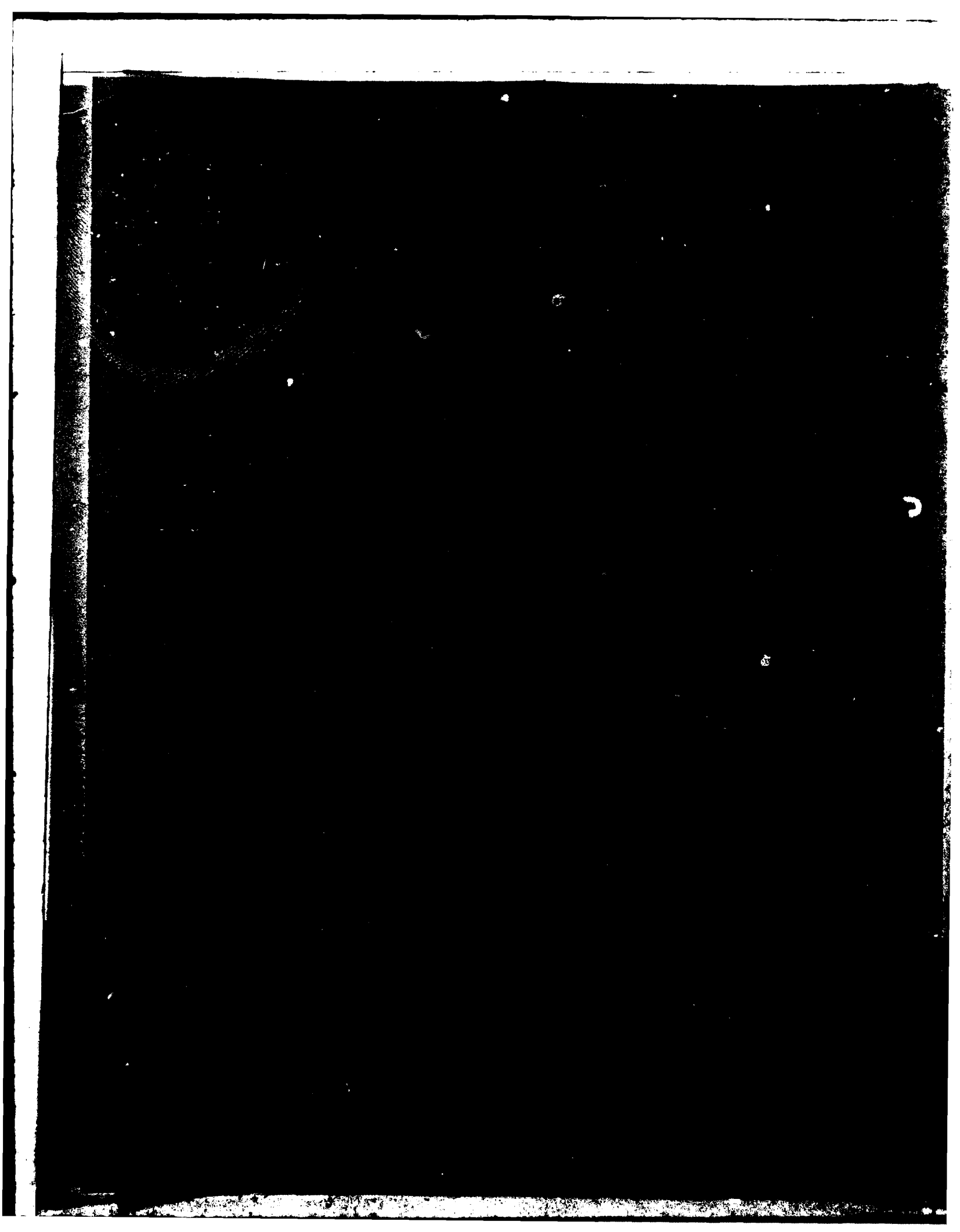
A PROTOTYPE SYSTEM APPROACH FOR THE DEFINITION  
OF MEDICAL INFORMATION REQUIREMENTS



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## INTRODUCTION

The Navy Occupational Health Information Monitoring System (NOHIMS) currently being developed by the Naval Health Research Center (NHRC) in San Diego is designed to coordinate the components of the U.S. Navy's overall occupational health program.<sup>(1, 2)</sup> The primary objectives of NOHIMS are to a) identify the personnel employed at an activity, b) determine the hazardous exposures in workplace environments, c) evaluate the worker's exposures and schedule those with a potential health risk for an examination, and d) maintain an historical file of the medical and environmental data. Therefore, NOHIMS will help satisfy the requirements that the Chief, Bureau of Medicine and Surgery (BUMED) develop a program for medical surveillance and establish appropriate records for an occupational health program.

This report describes the operation of a prototype system implemented at a local Navy facility and how it has been used as a device to integrate design concepts with the actual functioning and experiences of an occupational health clinic. In addition, the impact of NOHIMS on occupational health resource management is evaluated and discussed.

## THE PROTOTYPE SYSTEM

Data files. Three basic data files are needed to accomplish three primary objectives of NOHIMS. These files include the personnel data, the environmental data, and the medical data. The personnel data is obtained from the personnel department of the local facility participating in the NOHIMS pilot program. This file contains demographic and administrative information (e.g., name, social security number, date of birth, job title code, shop and building assignment, etc.) for all workers (approximately 6,000) at the pilot facility. Each month an updated file is obtained, thereby allowing NOHIMS to utilize the most current personnel information available for monitoring workers in the system.

The environmental data is provided by industrial hygienists from the Navy Regional Medical Center. Industrial hygienists routinely survey all work areas within Navy industrial activities identifying the contaminants present and the measured concentration of each one. It was therefore possible to develop the environmental data file by abstracting information from previously completed surveys.

The only medical data presently entered into NOHIMS are the specific clinical and laboratory tests received by each worker during his or her periodic examination. However, the software is being developed to have the actual laboratory results entered into the system, and eventually the capability to maintain an entire patient record will be incorporated into NOHIMS.

## SCHEDULING PHYSICAL EXAMINATIONS

These three types of data--personnel, environmental, and medical--can be used to perform a variety of occupational health functions as well as to generate the reports used for medical monitoring. One major function performed by NOHIMS is the scheduling of periodic physical examinations. To accomplish this function, a pass through the personnel file is executed and those employees whose birth month corresponds to the current date are identified. Then the exposure history for these people is determined by using the building and shop designation provided by the personnel file to locate the survey data for each employee's workplace. Finally, the person's workplace exposures are evaluated by comparing the measured concentration of each hazardous material

to the appropriate entry in the table of threshold limit values<sup>(3)</sup> and medical surveillance action levels.

Once an employee is found to be potentially exposed to one or more hazardous materials, each material present in the employee's workplace is used to locate information in another table regarding the medical protocol recommended for exposure to the specified substance. This table of medical protocols contains for each hazardous material a list of the historical information a physician should inquire about, the elements that should be included in a physical examination, and the laboratory tests and medical procedures that should be conducted. After the above steps have been completed, the information that has been retrieved is printed in a report called the Individual Environmental Exposure Report (IEER). This process is illustrated in Figure 1.

#### PILOT TESTING THE PROTOTYPE SYSTEM

Implementation and modification. Extensive consultation with personnel from the Navy Regional Medical Centers in San Diego and Pearl Harbor was conducted prior to the development of NOWINS and the information gained guided the design of NOWINS. From user input on the recordkeeping and reporting requirements, preliminary specifications for collecting, processing, and displaying medical and environmental data were developed.<sup>(4)</sup> However, it was clear that many questions could not be answered until the users had a chance to work with the system. Therefore, an interim system was developed and implemented as a tool to facilitate communication between the system designers and the intended users.

This interim system became operational in March 1982. Soon the modification process began. The first change was in the method used to notify workers of the time and date of their physical examination. Previously, workers were notified by their division clerks after the division clerk was contacted by the dispensary. The division clerk then completed a Standard Form 5188 (Dispensary Chit) for each worker to take to the dispensary at the time of his physical examination. It was decided that for planning purposes and ease of completion, physical examination notices (similar to the dispensary chit) would be computer-generated at the beginning of each month (see Figure 2). This allowed the division clerks to schedule exams for their division throughout the month depending on workload and manpower needs. It also eliminated having to fill in routine information such as name, social security number, building, and shop number for each worker on his dispensary chit. Division clerks and dispensary personnel have responded favorably to this modification in the scheduling process.

Another important change in NOWINS was the revision of the IEER which was prepared for the examining occupational health physician prior to each worker's periodic examination. The report was originally designed with input from a number of physicians and occupational health nurses to serve as a means of alerting the health care provider to a worker's potential exposures as well as supplying information about required and recommended medical surveillance for those exposures. After using the initial form for a period of time the physicians suggested that a table be included showing the measured concentration of the hazardous substances a worker had been exposed to as well as the percentage of the time-weighted Threshold Limit Value (TLV), or a percentage of the Short Term Exposure Limit (STEL), depending upon the type of sample taken. It was felt that such information could be used by a physician as a quick reference guide showing the hazards a worker had

been exposed to, the actual level of exposure, and the exposure level as a percentage of the standards recommended by the American Conference of Governmental Industrial Hygienists.<sup>(3)</sup>

The physicians using the prototype system also found that the original format of the IEER was somewhat cumbersome because the complete set of medical requirements were listed for each contaminant separately. For example, if a worker was potentially exposed to ten different contaminants, the IEER would list ten sets of physical examination requirements--one set for each contaminant. As a result, whenever multiple exposures occurred, the list contained overlapping items if the same test was required by two or more of the hazards. Feedback from the physicians using the IEER indicated that it would be helpful to design software to collate the elements of all the sets of the medical protocols, eliminate equivalent items, and produce a single list devoid of any repetition. This modification greatly reduced the size of the report, making it much easier to review.

Although the physicians who have used both versions of the IEER have stated that the newer version, shown in Figure 3, saves time, they have suggested a further modification. They point out that there are times when a physician may want to know why a certain laboratory test or clinical procedure appears on the medical protocol list. In other words, the exposure(s) that caused a particular item to be printed should be identified on the report. To accommodate this request, software is being developed that will generate a list of codes after each item on the IEER medical protocol identifying the relevant contaminants.

#### SYSTEM IMPACT

NOHIMS was initially implemented on an interim basis so that users' comments and suggestions for improving the system could be elicited and integrated into the program. To determine the actual effect and impact of these changes on the occupational health practices at the pilot facility, an analysis of the number of laboratory tests performed per month was conducted. Data were collected and compiled for the month prior to, and for four months after the introduction of the system at the NOHIMS pilot facility. Medical test data were collected on all workers receiving a physical examination for health-monitored occupations through the use of the Physical Examination Summary for Health-Monitored Occupations (see Figure 4).

Workers receiving examinations were divided into three categories as follows: Type 1--workers exposed to no hazards (no exposures); Type 2--workers exposed to some hazards but not those in Type 3 (exposed to non-X); Type 3--workers exposed to either one or some combination of acrylonitrile, asbestos, benzene, and/or lead (exposed to X).

The four Type 3 substances are found at the pilot facility and require monitoring by Occupational Safety and Health Act (OSHA) standards.<sup>(3)</sup> Thus, the workers exposed to these substances should have been monitored both before and after implementation of the prototype system.

The number of medical surveillance tests performed by type of exposure at the pilot facility for the months February through June 1982 is shown in Table 1. For each of these five months, the table provides the number of tests for each of three types of exposure, followed by the frequency expressed as a percentage of total number of tests performed. Using February 1982 as the baseline month prior to implementation of the prototype system, it can be seen from Table 1 that there was a steady increase in the percentage of tests performed for workers exposed to either one or some



combination of acrylonitrile, asbestos, benzene, and lead (Type 3 workers), and a decrease in the percentage of tests performed for workers exposed to no hazards (Type 1 workers). For instance, in February 1982, only 11% of all medical surveillance tests were performed on Type 3 workers, but in June 1982 this percentage had increased to 49%. Conversely, in February 1982, 32% of all medical surveillance tests performed were performed on workers exposed to no hazards, and by June 1982 this percentage had decreased to 13%. It should be noted that some medical tests are given to workers with no exposures because certain occupations (e.g., drivers and crane operators) require these tests for certification.

The number of medical surveillance tests performed by type of exposure for each month of the four months after implementation of the interim MONIMS was compared statistically to the February 1982 baseline pre-implementation month using a chi-square test of independence. By March 1982 the improvement had already reached statistical significance ( $p < .001$ ), with a larger number of medical tests being performed for workers with more critical exposures and fewer tests being performed for workers with no exposures compared to February 1982. This same level of statistical significance was maintained in the comparisons between the April, May, and June 1982 data with that of February 1982.

#### CONCLUSION

One way to insure that any employee exposed to hazardous materials in the workplace is properly examined is to periodically give all personnel a full battery of examinations. Clearly this solution is not practical or feasible, but the opposite extreme of conducting no physical examinations is just as unacceptable. The problem, then, is to find the optimal balance: to examine those personnel with a significant health risk while limiting the total impact on the available medical facilities. The data obtained thus far indicate that the implementation and modification of MONIMS have resulted in changes directed toward such a balance, with proportionately more medical tests being performed on workers with critical exposures and proportionately fewer tests being performed on workers with no exposures to any hazards. It is felt that these improvements in the efficiency of the occupational health surveillance program are a direct result of the ongoing interaction between occupational health physicians, division clerks, programmers, and systems personnel involved in the development and field testing of MONIMS. Moreover, it is believed that this experience is not unique; therefore, it is suggested that during the design of any information system, one should consider using an interim system that could be modified according to user feedback. Then initial design concepts can be tested, users' experience and knowledge can be utilized, and, because the user becomes a participant in the system's development, he becomes more enthusiastic about accepting the system.

#### REFERENCES

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3. TLVs: Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1988. American Conference of Governmental Industrial Hygienists, P.O. Box 1937, Cincinnati, Ohio.
4. Hermansen, L., & Pugh, W.M. A system for monitoring employee health in a Navy occupational setting. Report No. 81-3, Naval Health Research Center, San Diego, California, 1981.
5. OSHA Medical Surveillance Requirements and NIOSH Recommendations. Bio-Technology, Inc., 3827 Rosemary Lane, Falls Church, Virginia, January, 1988.

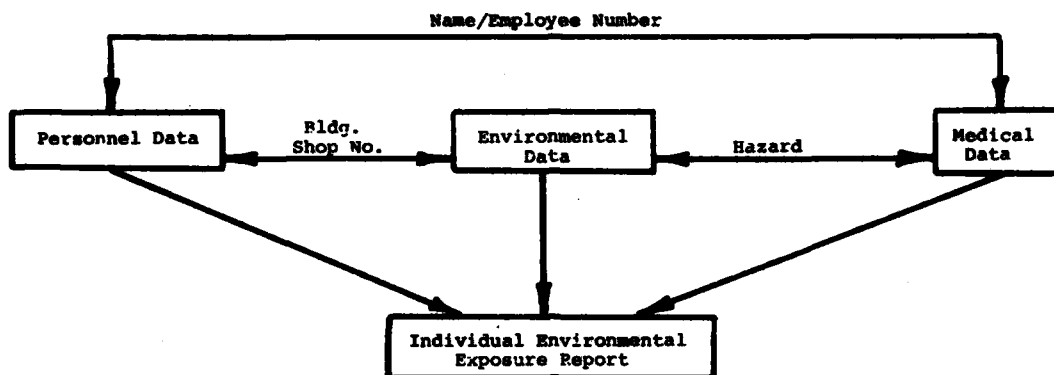


Figure 1. Links Among NOHIMS Data Files

**PERIODIC PHYSICAL EXAMINATION NOTICE**

NAME	SSN	BLDG	DIV/SHIP
DOE John E.	123-48-6799	0378	6220

YOU ARE DIRECTED TO REPORT TO MS. NANCY BARTOW, INDUSTRIAL MEDICINE CLINIC, BLDG. 14, on  
 ON \_\_\_\_\_ AT \_\_\_\_\_. YOU ARE TO BRING BOTH COPIES OF THIS NOTICE FOR THIS  
           DATE                  TIME

NARF OCCUPATIONAL HEALTH MONITORING EXAMINATION.

\*\*\*\*\*

TIME LEFT JOB \_\_\_\_\_ TIME RETURNED \_\_\_\_\_

SUPERVISOR'S SIGNATURE \_\_\_\_\_

\*\*\*\*\*

TIME REPORTED \_\_\_\_\_ TIME RELEASED \_\_\_\_\_

MEDICAL OFFICER'S SIGNATURE \_\_\_\_\_

\*\*\*\*\*

REMARKS:

Figure 2. Computer Generated Physical Examination Notice

INDIVIDUAL ENVIRONMENTAL EXPOSURE REPORT

AUGUST 1982

FORM NHR-A  
REV. 021282

NAME: John Doe EMPLOYEE NUMBER: 12345  
SSN: 123 45 6789 BUILDING: 0001  
SEX: MALE SHIP: 93436  
AGE: 61 DATE OF BIRTH: 05/05/20 JOB TITLE: PLASTIC WORKER

PHYSICAL RESTRICTIONS: NONE

POTENTIAL EXPOSURES

CONTAMINANT	LEVEL	TLV	STEL	ESTEL
DISTYLENE TRIAMINE	.01PPM	0.		0.
ISOCYANATES	.04PPM	0.		0.
ISOPROPYL ALCOHOL	600PPM	150.		0.
METHYL ETHYL KETONE	5PPM	3.		0.
NOISE (TWA)	78.4DBA	92.		0. PLASTICS
NOISE (TWA)		0.	115DBA	100. COMPOSITE
NOISE (TWA)	115DBA	135.		0. MACHINERY ROOM

HEALTH EFFECTS

ISOCYANATES

ISO-PROPYL ALCOHOL

NOISE (TWA)

\*\*\*\*\*MEDICAL SURVEILLANCE\*\*\*\*\*

CNS DEPRESSANT

SKIN IRRITATION

MUCOUS MEMBRANES (EYES, NOSE, ORAL CAVITY) IRRITATION

THE FOLLOWING MEDICAL SURVEILLANCE APPROACH IS RECOMMENDED:

HISTORY, ESPECIALLY FOR:

ALCOHOL INGESTION

EXPOSURE TO CHEMICAL IRRITANTS, MUTAGENS, CNS DEPRESSANTS

WORK HISTORY OF:

EXPOSURE TO IRRITANT CHEMICALS

PREVIOUS EXPOSURE TO CNS DEPRESSANTS

PAST MEDICAL HISTORY AND REVIEW OF SYSTEMS:

SKIN DISORDERS

MUCOUS MEMBRANES (EYES, NOSE, ORAL CAVITY) DISORDERS/SYMPTOMS

RESPIRATORY TRACT DISORDERS/SYMPTOMS

PHYSICAL EXAMINATION, ESPECIALLY:

SKIN

MUCOUS MEMBRANES (EYES, NOSE, ORAL CAVITY)

RESPIRATORY

COMMENTS:

ISOPROPYL ALCOHOL IS USED IN SOLVENTS AND HYDRAULIC FLUID. IT IS AN IRRITANT OF THE EYES, MUCOUS, MEMBRANES AND RESPIRATORY TRACT. DERMATITIS OCCURS INFREQUENTLY. EMPHASIS ON MEDICAL SURVEYS IS ON THE SKIN, MUCOUS MEMBRANES AND RESPIRATORY SYSTEMS, AND HISTORY OF CHRONIC ALCOHOLISM.

Figure 3. Computer Generated Individual Environmental Exposure Report (IESR).

**PHYSICAL EXAMINATION SUMMARY FOR HEALTH MONITORED OCCUPATIONS**

3. Social Security Number \_\_\_\_\_

YES \_\_\_\_\_ NO \_\_\_\_\_

**CLINICAL TESTS (Check all that apply)**

1. Blood (specify heavy metal ion tested for \_\_\_\_\_)
2. Blood flourides \_\_\_\_\_
3. Blood acetone \_\_\_\_\_
4. Blood cyanide \_\_\_\_\_
5. Chest X-ray \_\_\_\_\_
6. Pulmonary Function \_\_\_\_\_
7. Radon breath \_\_\_\_\_
8. Special eye examination \_\_\_\_\_
9. Nasal Examination \_\_\_\_\_
10. Urine mercury \_\_\_\_\_
11. EKG \_\_\_\_\_
12. Carboxyhemoglobin \_\_\_\_\_
13. Fibrinolytic activity assay \_\_\_\_\_
14. SMA-4 \_\_\_\_\_
15. SMA-12 \_\_\_\_\_
16. Skin exam for dermatitis \_\_\_\_\_
17. Audiogram \_\_\_\_\_
18. Cholinesterase \_\_\_\_\_
19. Eosinophile count \_\_\_\_\_
20. Liver function test \_\_\_\_\_
21. Kidney function test \_\_\_\_\_
22. Urinalysis \_\_\_\_\_
23. CBC \_\_\_\_\_
24. Other clinical test(s) (specify) \_\_\_\_\_

**Figure 4. Physical Examination Summary for Health Monitored Occupations.**

Table 1

Number of Medical Surveillance Tests Performed by  
Type of Exposure for the Months  
February through June 1982

Time Period Covered	MEDICAL SURVEILLANCE TESTS PERFORMED						Total Number of Tests Performed
	No Exposures		Exposed to Non-X*		Exposed to X*		
	No.	%	No.	%	No.	%	
Feb '82	102	32	185	57	36	11	323
Mar '82	90	27	127	39	111	34	328
Apr '82	35	18	98	51	59	31	192
May '82	48	20	123	52	65	28	236
Jun '82	26	13	80	38	102	49	208

X\* = either one or some combination of acrylonitrile, asbestos, benzene, and lead.

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system are discussed and the impact of NOHIMS on the program at a pilot facility is evaluated by analyzing the patterns of laboratory tests performed before and after the implementation of NOHIMS. This analysis indicated that the implementation of NOHIMS resulted in fewer tests for employees with minimal exposures and more tests for personnel with serious exposures. It was concluded that NOHIMS improved the utilization of the clinic's resources and that the interim system contributed to the system's efficiency by facilitating communication between the system's designers and users.

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